Space Weather Technical Forecast

Issued on Friday, 20 October 2023 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Weak CME arrivals possible, with a Slight Chance of isolated G1/Minor Geomagnetic Storm intervals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity as recorded at GOES16 and 18 has been Low over the past 24 hours, with only low level C-class flares, the largest of which was a C2.7 which peaked at 19/1400 UTC from AR3465. There are currently three numbered regions on the visible disc and one unnumbered regions, all of which are relatively small and simple, and either stable or in decline.
A Coronal Mass Ejection (CME) is apparent in imagery, starting around 19/1800 UTC from the southeast quadrant from a filament eruption. This event is considered unlikely to be Earth directed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1 started at slightly elevated levels around 430 km/s and then soon declined to background levels and are now around 370 km/s. The phi angle was positive (away from the Sun) throughout. The solar wind density started at below average levels, before increasing to around 14pppc after 20/0800UTC. The IMF was weak throughout the period. The north-south component (Bz) was weakly negative, reaching -6 nT at 19/1253 UTC. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background.
GOES16 high energy (greater than 2MeV) electron flux was at mostly Normal Background levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold on a flat trend. The observation at 20/0001UTC was 1.33e6 integrated pfu, after a gradually decreasing trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Low solar activity is likely to continue. There is a Slight Chance of isolated M-class X-ray flares through the period, with any significant flares most likely from AR3465 on the visible disc but also from regions currently on the far side of the Earth which may rotate onto the Earth facing side within the forecast period.

Solar Wind / Geomagnetic Activity: The geomagnetic forecast carries high uncertainty, as evidenced by the MOSWOC Enlil ensemble spread. There are two or three potentially Earth directed CMEs. The C7.5 flare CME from the 16 October is now discounted as affecting Earth. Secondly, a CME associated with a filament eruption on 17 October may arrive in the next 12 to 24 hours. Thirdly and finally, a CME from an eruption on 18 October might follow this event by a further 12 to 24 hours. Therefore today, tomorrow and day 3 (20-22nd Oct) there is chance of geomagnetic activity becoming enhanced. A potential weak enhancement from CH62/- may arrive over the next day or two but confidence is low as the coronal hole feature is now small

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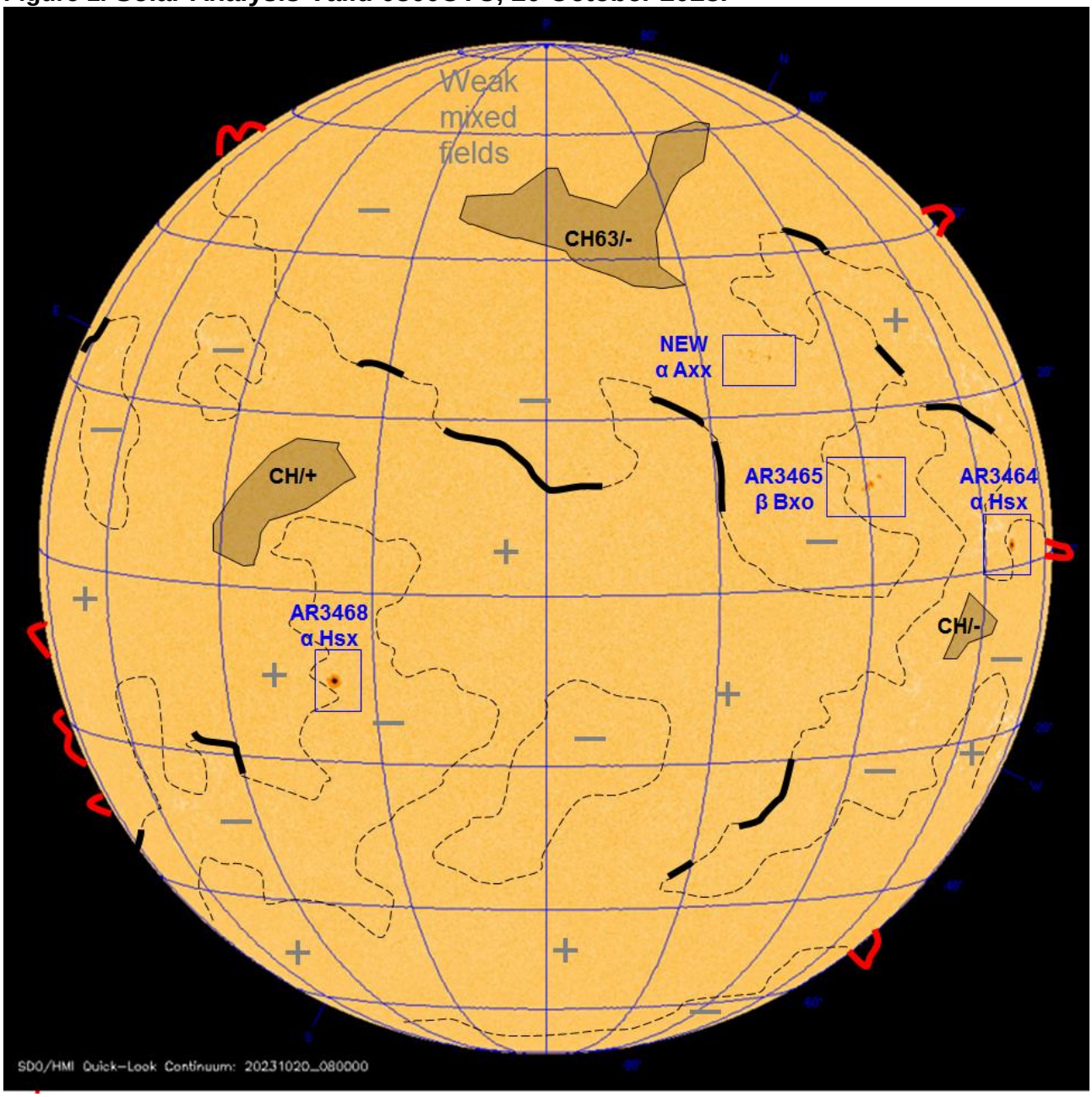
and diminishing. CH63/- in the northwest or the visible disc could give enhanced solar winds later in the period. Geomagnetic activity is likely to be Quiet (Kp 0-2) for much of the time, but with spells of Unsettled to Active (Kp 3-4) and a Chance or Slight Chance of G1/Minor Storm (Kp 5) intervals if and when any glancing CME's affect Earth.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to persist at Background levels.
High energy electron flux (greater than 2MeV) is expected to be at Normal Background, perhaps rising to Moderate depending on the strength of any CME-sourced enhancement that occurs. The associated 24-hour electron fluence is expected to remain below Active (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 0800UTC, 20 October 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The geomagnetic forecast is complex and carries high uncertainty, but overall the forecast is for relatively low activity. There is a significant overlap in inbound CME arrival times as evidenced by the MOSWOC Enlil ensemble spread. There are three possibly Earth directed CME's. First is the CME which left the northeast disc on 16 October, associated with the C7.5 from AR3467. The bulk of the material has now probably passed behind Earth and can now be discounted. Another CME was also observed from a filament eruption near Ex-AR3463 off the southwest disc early on 17 October. This is also expected to largely miss, passing ahead and south of Earth, but with the potential for a glancing impact either late today or early tomorrow (Friday 20th into Saturday 21st October). The final CME was observed from the southeast around 18/0530UTC. This has been assessed as passing to the south and behind Earth late tomorrow or early day 3 (Saturday 21 into Sunday 22 October), also with a slight chance of glancing impacts.

A potential weak enhancement from CH62/- may arrive over the next two days. However, confidence is low as this coronal hole feature is now small and diminishing and therefore much-reduced compared to the previous 27-day solar rotation, when very little enhancement was observed. Geomagnetic activity is likely to be Quiet (Kp 0-2) for much of the time, but with spells of Unsettled to Active (Kp 3-4) activity and a Chance or Slight Chance of G1/Minor Storm (Kp 5) intervals if and when any glancing CME's arrive.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/1730	Partial	C7.5/AR3467	NE	680	20/0100UTC	Missed Earth
17/1430	Partial	Filament	SW	480	Late 20th or early 21st	Very low confidence. Likely miss
18//1132	Partial	Filament	SE	610	Late 21st or 22nd	Very low confidence. Likely miss

Figure 2: : Met Office Enlil Ensemble forecast.

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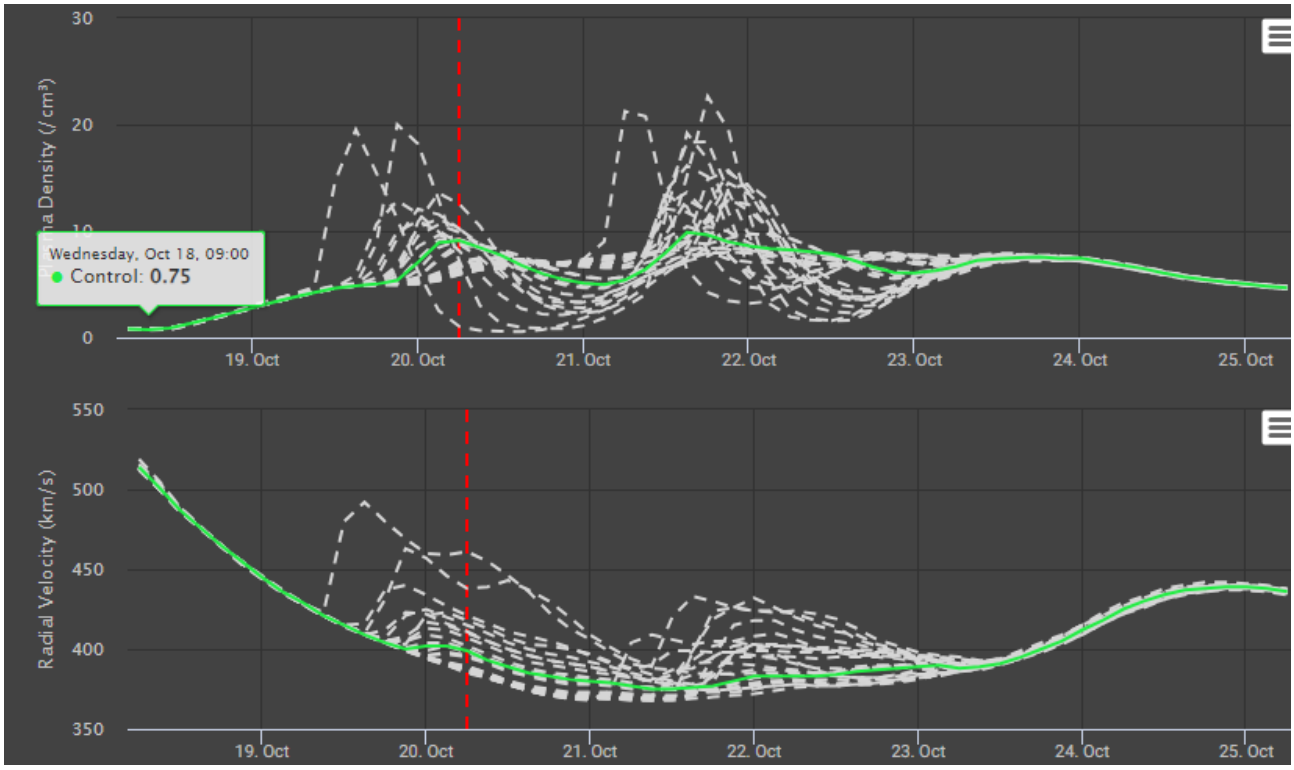
Radio Blackouts - X-Ray Flares:

There are currently three numbered regions on the visible disc, and a few barely visible unnumbered regions. All regions are small, simple and either stable or were previously in decline. Activity is expected to remain Low, with only isolated C-class flares likely in the absence of any significant regions currently on the visible disc. However, towards the end of the period new or returning regions may rotate on from the far side, which is indicated in the slight increase in flare probabilities.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	5	5	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: : Met Office Enlil Ensemble forecast.



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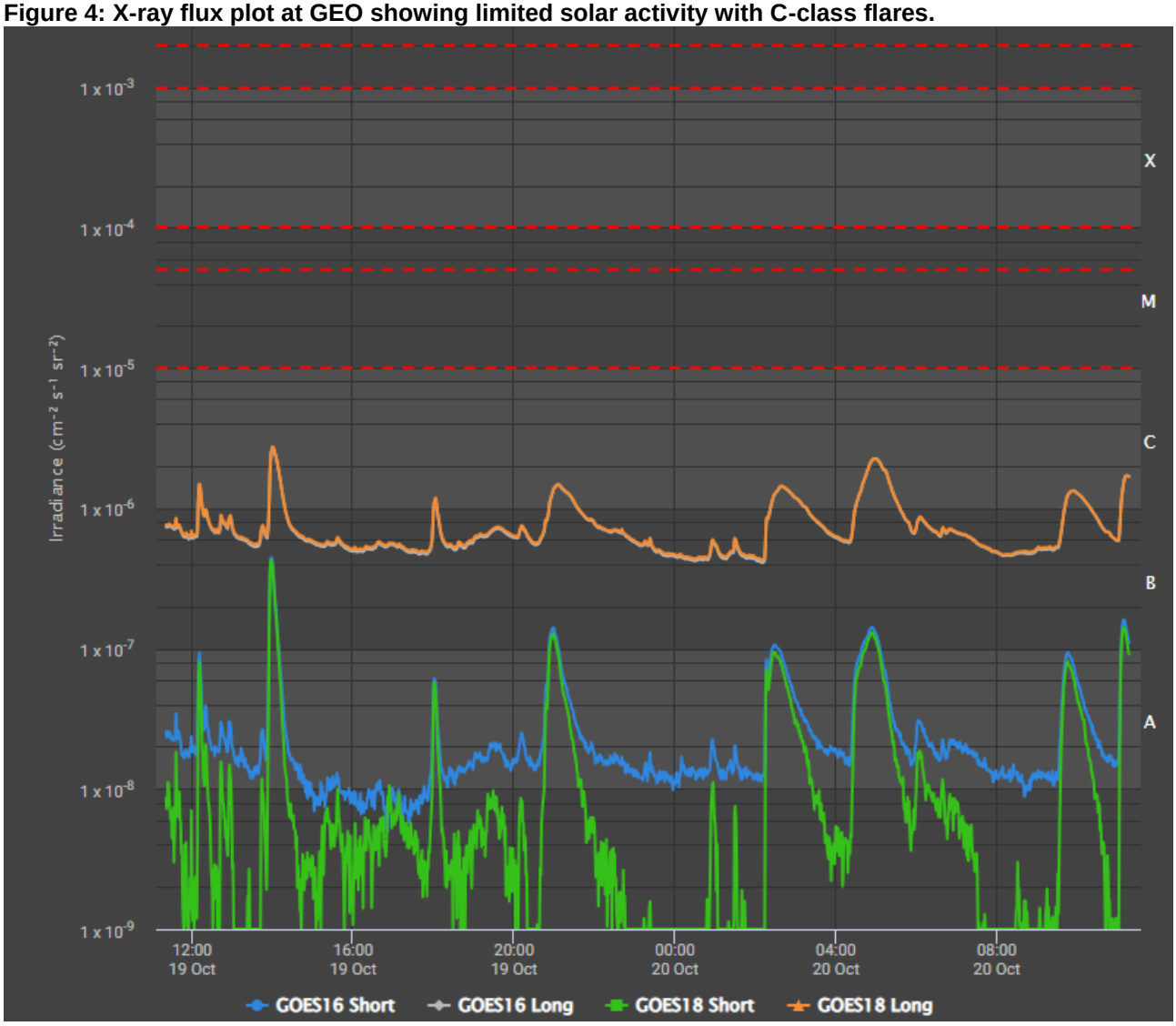
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at Background levels, due to the lack of significant regions on the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: X-ray flux plot at GEO showing limited solar activity with C-class flares.



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High Energy Electrons Event (≥ 2MeV):
Electron flux observed by GOES16 at GEO is currently at Normal Background levels. Solar wind enhancements are possible through the coming days, mainly associated with a number of potential CME arrivals throughout the period, or the onset of a weak HSS from the small coronal hole CH62/-. These are all low confidence however, and any enhancement is expected to be largely weak. These may increase electron populations in the Van Allen belts at times, which could bring periods of Moderate flux, most likely towards the end of the period.
The associated 24-hour fluence is expected to remain well below the Active threshold, as supported by MOSWOC REFM output. However, the model will only provide good guidance in the absence of any CME or fast wind enhancements. Therefore, with the chance of a weak HSS and potential glancing blows from CME's, fluence levels may increase slightly towards the end of the forecast period, and this trend is not indicated by REFM.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM output.

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